AMENDMENTS TO THE CLAIMS

This listing of claims will replace all prior versions, and listings, of claims in the application:

LISTING OF CLAIMS

1-70. (Canceled)

71. (Currently Amended) In a fuel conversion reactor, a shell-and-tube heat exchanger for heating a gaseous fluid prior to reaction with a fuel and for cooling a gaseous mixture produced by the reaction, said heat exchanger comprising:

(a) a first heat exchanger section comprising:

(i) a first primary shell member having primary and secondary ends and a sidewall extending between said ends and defining a first heat exchanging chamber located within the first primary shell member;

(ii) a first tube sheet fixedly mounted on said first primary shell member in the vicinity of said primary end and sealingly closing said first heat exchanging chamber at one end of the first chamber;

(iii) a ~~second~~ first tube sheet device which is separate from said first primary shell member and is located in the vicinity of said secondary end, said ~~second~~ first tube sheet device forming another end of said first chamber that is opposite said one end of the first chamber; and

(iv) a first plurality of heat exchange tubes extending from said first tube sheet to said ~~second~~ first tube sheet device and rigidly connected to both the first tube sheet and the ~~second~~ first tube sheet device, said heat exchange tubes providing passageways for said gaseous mixture to flow inside the tubes through said first heat exchanging chamber; and

(v) one or more outlet apertures formed in the region of said secondary end of said first primary shell member in order to provide at least one outlet for said gaseous fluid which flows through said first heat exchanging chamber on a shell-side thereof during operation of said fuel conversion reactor; and

(b) a second heat exchanger section comprising:

(i) a second primary shell member having primary and secondary ends and a sidewall extending between said ends and defining a second heat exchanging chamber in flow communication with the first heat exchanging chamber, the second primary shell member being concentric with the first primary shell member with the primary end of the first primary shell member being located proximate the secondary end of the second primary shell member;

(ii) a second plurality of heat ~~exchanging~~ exchange tubes mounted in the second primary shell member and communicating with the heat exchange tubes of the first heat exchanger section;

(iii) an inlet in the sidewall of the second primary shell member for introducing the gaseous fluid into the second heat exchanging chamber;

(iv) one or more outlet apertures formed in the region of the secondary end of the second primary shell member to provide at least one outlet for the gaseous fluid to flow from the second heat exchanging chamber to the first heat exchanging chamber;

wherein the first heat exchanger section further comprises one or more inlet apertures formed in the region of the primary end of the first primary shell member to provide at least one inlet for the gaseous fluid to flow into the first heat exchanging chamber from the second heat exchanging chamber.

72. (Canceled)

73. (Currently Amended) A fuel conversion reactor according to claim [[72]] 71, further comprising an outer shell section having first and second ends surrounding the secondary end of the second primary shell member and the primary end of the first primary shell member and forming a passageway for flow of the gaseous fluid from the second heat exchanging chamber to the first heat exchanging chamber, the first and second ends of the outer shell section being rigidly attached to the respective sidewalls of the first and second primary shell members, said passageway being formed between the outer shell section and the shell members.

74. (Currently Amended) A fuel conversion reactor according to claim 73, wherein the one or more outlet apertures formed in the region of the secondary end of the second primary shell member are formed between the first and second primary shell members.

75. (Currently Amended) A fuel conversion reactor according to claim 74, wherein the one or more outlet apertures formed in the region of the secondary end of the second primary shell member comprises a disconnected joint between the first and second primary shell members.

76. (Currently Amended) A fuel conversion reactor according to claim [[72]] 71, wherein the primary end of the first primary shell member is of a greater diameter than the secondary end of the second primary shell member and wherein the secondary end of the second primary shell member is received inside the primary end of the first primary shell member, and wherein the primary end of the first primary shell member is rigidly attached to the sidewall of the second primary shell member such that a passageway for flow of the gaseous fluid from the second to the first heat exchanging chamber is formed between the first and second primary shell members.

77. (Currently Amended) A fuel conversion reactor according to claim 76, wherein the one or more inlet apertures comprise a continuous annular gap between the first and second primary shell members.

78. (Currently Amended) A fuel conversion reactor according to claim [[76]] 71, wherein the one or more inlet apertures comprises a disconnected joint formed in the sidewall of the first primary shell member proximate its primary end.

79. (New) A fuel conversion reactor according to claim 71, wherein the second heat exchanger section further comprises:

a second tube sheet fixedly mounted on said secondary shell member in the vicinity of said secondary end thereof and sealingly closing said second heat exchanging chamber at one end of the second chamber; and

a second tube sheet device which is separate from said second primary shell member and is located in the vicinity of said secondary end thereof, said second tube sheet device forming another end of said second heat exchanging chamber that is opposite said one end of the second chamber;

wherein said second plurality of heat exchange tubes extend from said second tube sheet to said second tube sheet device and are rigidly connected to both the second tube sheet and the second tube sheet device, and wherein said second plurality of heat exchange tubes provide passageways for said gaseous mixture to flow inside the tubes through said second heat exchanging chamber.

80. (New) A fuel conversion reactor according to claim 71, wherein the inlet for introducing the gaseous fluid is provided in the primary end of the second primary shell member.

81. (New) A fuel conversion reactor according to claim 71, further comprising an outer shell having first and second ends and an outer shell wall extending between said first and second ends, said outer shell being closed at said second end;

wherein said outer shell wall extends around said first primary shell member and said first tube sheet device, and said outer shell wall is provided with an inlet for said fuel; and

wherein a fuel passageway is formed between said outer shell wall and said sidewall of the first primary shell member and extends from said inlet for the fuel to said one or more outlet apertures formed in the region of said secondary end of said first primary shell member.

82. (New) A fuel conversion reactor according to claim 71, wherein said first tube sheet device includes a first secondary shell member having a peripheral sidewall with one end of the first secondary shell member being located adjacent to said secondary end of the first primary shell member; and

wherein said fuel conversion reactor further comprises a first catalyst to catalyze the reaction of the fuel and the gaseous fluid, said first catalyst being mounted in said first secondary shell member.

83. (New) A fuel conversion reactor according to claim 82, wherein the first catalyst is a fuel transformation catalyst for converting a hydrogen-containing fuel to hydrogen.

84. (New) A fuel conversion reactor according to claim 83, wherein the first catalyst is an autothermal reformation catalyst.

85. (New) A fuel conversion reactor according to claim 82, further comprising a second catalyst located between the first tube sheet and the second tube sheet device into which said gaseous mixture flows from the first plurality of heat exchange tubes and from which said gaseous mixture flows to said second plurality of heat exchange tubes.

86. (New) A fuel conversion reactor according to claim 85, wherein said second tube sheet device includes a second secondary shell member having a peripheral sidewall with one end of the second secondary shell member being located adjacent to said secondary end of the second primary shell member; and wherein said second catalyst is mounted in said second secondary shell member.

87. (New) A fuel conversion reactor according to claim 85, wherein the second catalyst comprises a carbon monoxide cleanup catalyst.

88. (New) A fuel conversion reactor according to claim 87, wherein the second catalyst comprises a shift reaction catalyst.

89. (New) A fuel conversion reactor according to claim 71, further comprising an outlet for said gaseous mixture exiting said second plurality of heat exchange tubes, wherein the outlet for said gaseous mixture is provided at the primary end of the first primary shell member.

90. (New) A fuel conversion reactor according to claim 73, wherein said one or more outlet apertures formed in the region of the secondary end of the second primary shell member are in flow communication with said passageway for flow of the gaseous fluid formed by the outer shell section, such that the gaseous fluid enters said passageway through said one or more outlet apertures; and

wherein said one or more inlet apertures of the first heat exchanger section are in flow communication with said passageway, such that the gaseous fluid exits said passageway through said one or more inlet apertures.

91. (New) A fuel conversion reactor according to claim 90, wherein said one or more outlet apertures of the second primary shell member are in the form of a plurality of discrete apertures arranged in spaced relation to one another in said second primary shell member, and wherein said one or more inlet apertures of the first primary shell member are in the form of a plurality of discrete apertures arranged in spaced relation to one another in said first primary shell member.

92. (New) A fuel conversion reactor according to claim 71, wherein said one or more outlet apertures formed in the region of the secondary end of the first primary shell member comprises a disconnected joint between the sidewall of the first primary shell member and the first tube sheet device.

93. (New) A fuel conversion reactor according to claim 77, wherein said one or more outlet apertures formed in the region of the secondary end of the second primary shell member are in flow communication with said passageway for flow of the gaseous fluid formed between the first and second primary shell members, such that the gaseous fluid enters said passageway through said one or more outlet apertures; and

wherein said gaseous fluid exits said passageway through said continuous annular gap between the first and second shell members.

94. (New) In a fuel conversion reactor, a shell-and-tube heat exchanger for heating a gaseous fluid prior to reaction with a fuel and for cooling a gaseous mixture produced by the reaction, said heat exchanger comprising:

(a) a first heat exchanger section comprising:

(i) a first primary shell member having primary and secondary ends and a sidewall extending between said ends and defining a first heat exchanging chamber located within the first primary shell member;

(ii) a first tube sheet fixedly mounted on said first primary shell member in the vicinity of said primary end and sealingly closing said first heat exchanging chamber at one end of the first chamber;

(iii) a first tube sheet device which is separate from said first primary shell member and is located in the vicinity of said secondary end, said first tube sheet device forming another end of said first chamber that is opposite said one end of the first chamber;

(iv) a first plurality of heat exchange tubes extending from said first tube sheet to said first tube sheet device and rigidly connected to both the first tube sheet and the first tube sheet device, said heat exchange tubes providing passageways for said gaseous mixture to flow inside the tubes through said first heat exchanging chamber;

(v) one or more outlet apertures formed in the region of said secondary end of said first primary shell member in order to provide at least one outlet for said gaseous fluid which flows through said first heat exchanging chamber on a shell-side thereof during operation of said fuel conversion reactor;

(vi) an outer shell having first and second ends and an outer shell wall extending between said first and second ends, said outer shell being closed at said second end, extending around said primary shell member and said first tube sheet device, and having an inlet for said fuel, wherein a fuel passageway is formed between said outer shell wall and said sidewall of the primary shell member and extends from said inlet for the fuel to said one or more outlet apertures; and

(vii) a first inlet in the sidewall of the first primary shell member for introducing a first said gaseous fluid into the first heat exchanging chamber;

(b) a second heat exchanger section comprising:

(i) a second primary shell member having primary and secondary ends and a sidewall extending between said ends and defining a second heat exchanging chamber, the second primary shell member being concentric with the first primary shell member with the primary end of the first primary shell member being located proximate the secondary end of the second primary shell member with a mixing chamber defined therebetween;

(ii) a second plurality of heat exchange tubes mounted in the second primary shell member in flow communication with the heat exchange tubes of the first heat exchanger section through said mixing chamber;

(iii) a second inlet in the sidewall of the second primary shell member for introducing a second said gaseous fluid into the second heat exchanging chamber;

(iv) one or more outlet apertures formed in the region of the secondary end of the second primary shell member to provide at least one outlet for the gaseous fluid to flow from the second heat exchanging chamber to the mixing chamber;

wherein the first tube sheet seals the first heat exchanging chamber against flow communication with the mixing chamber and the second heat exchanging chamber.

95. (New) A fuel conversion reactor according to claim 94, wherein the primary end of the first primary shell member is of a greater diameter than the secondary end of the second primary shell member and wherein the secondary end of the second primary shell member is received inside the primary end of the first primary shell member, and wherein the primary end of the first primary shell member is rigidly attached to the sidewall of the second primary shell member such that a passageway for flow of the gaseous fluid from the second heat exchanging chamber to the mixing chamber is formed between the first and second primary shell members.

96. (New) A fuel conversion reactor according to claim 94, wherein the second heat exchanger section further comprises:

a second tube sheet fixedly mounted on said secondary shell member in the vicinity of said secondary end thereof and sealingly closing said second heat exchanging chamber at one end of the second chamber; and

a second tube sheet device which is separate from said second primary shell member and is located in the vicinity of said secondary end thereof, said second tube sheet device forming another end of said second heat exchanging chamber that is opposite said one end of the second chamber;

wherein said second plurality of heat exchange tubes extend from said second tube sheet to said second tube sheet device and are rigidly connected to both the second tube sheet and the second tube sheet device, and wherein said second plurality of heat exchange tubes provide passageways for said gaseous mixture to flow inside the tubes through said second heat exchanging chamber.

97. (New) A fuel conversion reactor according to claim 94, wherein the first inlet for introducing the first gaseous fluid is provided in the primary end of the first primary shell member and the second inlet for introducing the second gaseous fluid is provided in the primary end of the second primary shell member.

98. (New) A fuel conversion reactor according to claim 94, wherein said first tube sheet device includes a first secondary shell member having a peripheral sidewall with one end of the first secondary shell member being located adjacent to said secondary end of the first primary shell member; and

wherein said fuel conversion reactor further comprises a first catalyst to catalyze the reaction of the fuel and the first gaseous fluid to produce a first said gaseous mixture, said first catalyst being mounted in said first secondary shell member.

99. (New) A fuel conversion reactor according to claim 98, wherein the first catalyst is a fuel transformation catalyst for converting a hydrogen-containing fuel to hydrogen.

100. (New) A fuel conversion reactor according to claim 99, wherein the first catalyst is an autothermal reformation catalyst.

101. (New) A fuel conversion reactor according to claim 98, wherein said mixing chamber receives said first said gaseous mixture from said first plurality of heat exchange tubes and said second gaseous fluid from said second heat exchanging chamber, and wherein said fuel conversion reactor further comprises a second catalyst in which said first gaseous mixture and the second gaseous fluid are reacted to produce a second said gaseous mixture, and from which said second gaseous mixture flows to said second plurality of heat exchange tubes.

102. (New) A fuel conversion reactor according to claim 101, wherein said second tube sheet device includes a second secondary shell member having a peripheral sidewall with one end of the second secondary shell member being located adjacent to said secondary end of the second primary shell member; and wherein said second catalyst is mounted in said second secondary shell member.

103. (New) A fuel conversion reactor according to claim 101, wherein the second catalyst comprises a high temperature gas shift catalyst.

104. (New) A fuel conversion reactor according to claim 101, further comprising a third catalyst in which said second gaseous mixture received from said second plurality of heat exchange tubes is further reacted to produce a third said gaseous mixture.

105. (New) A fuel conversion reactor according to claim 104, wherein said third catalyst comprises a low temperature gas shift catalyst.